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Beck, Adam

The Hydro-electric Power  
Commission of Ontario

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The Hydro-Electric Power Commission  
OF ONTARIO

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ADDRESS

BY

SIR ADAM BECK

AT THE

PUBLIC OWNERSHIP CONFERENCE

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THE PUBLIC OWNERSHIP LEAGUE OF AMERICA  
Conference, September 10th to 13th, 1923, at Toronto, Ontario

## The Hydro-Electric Power Commission of Ontario

by

SIR ADAM BECK

THERE are certain features which must lie at the foundation of any movement such as that carried forward by the co-operating municipalities of the Province of Ontario—if such a movement is to succeed. First of all, there must be a genuine desire on the part of citizens to have electrical energy, or whatever the commodity may be, supplied to them under such conditions and circumstances as would prevail under public ownership.

The men who undertake to found a publicly-owned enterprise, especially during its initiatory stages, should be responsible and prominent citizens of good business standing and character, who will inspire and hold public confidence. Such men must be willing to make sacrifices on behalf of the new programme; for just as soon as it is perceived that matters are being undertaken in a serious and successful manner, just so soon will opposition begin to assert itself from various antagonistic sources. Courage, perseverance and other qualities will be called into action on the part of those who are standing sponsor for the new undertaking.

The necessary financial resources should be supplied by the people who will themselves benefit from the undertaking. Financial resources are required, even for the preliminary researches and investigation of the problem in hand. When the people begin to invest their own money in an enterprise, this procedure of itself arouses and assists to maintain interest.

Technical men of sound engineering, financial and other training must be engaged who will, with singleness of purpose, gather the facts and assist in forming sound judgment, based upon the data secured. Later they will be found guarding, directing and operating the publicly-owned utility.

Throughout the whole proceedings, the general public must be taken into confidence and kept adequately informed. As opportunity offers, the citizens should be educated to understand the general character of the various problems under consideration. In a word, unless there be a desire on the part of the citizens of a community to proceed on a basis of public-ownership; unless there be responsible and qualified public men ready to make sacrifices to achieve the results desired; unless competent technical assistance be employed, and unless the people themselves are ready to back the project with their financial resources, there is not, in my judgment, any satisfactory basis upon which to initiate and carry forward to a successful conclusion a programme of public ownership.

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From time to time, the Commission has received enquiries from various sections of this and other continents, requesting information respecting the operations of the Hydro-Electric Power Commission of Ontario. It is evident from many such enquiries that the enquirers entertained a hope that they would receive detailed knowledge of the operations of the municipally-owned hydro-electric undertaking in Ontario in such a form as would enable a similar project to be carried out in their own community. Some appear to forget the fact that each situation requires to be studied on its own merits, and the various essential factors properly evaluated before deciding upon what particular features of administration shall be adopted. In the case of this Commission many changes have had to be made in statutory enactments, regulations, rules and other items appertaining to the Commission's administration. A competent staff will soon discern where enactments are inoperative and how modifications may be effected.

I have been led to comment as I have been doing, because it is all-important to realize that certain basic circumstances and certain fundamentals of procedure must obtain if any movement such as that of the Hydro-Electric Power Commission of Ontario is to be initiated with any promise whatsoever of ultimate success.

Having made these observations, permit me now to turn to some of the achievements of the Hydro-Electric Power Commission of Ontario, and as these are set forth I believe you will readily discern the pertinence of the general comments which I have just made.

#### Early Conditions Which Prompted the Initiation of "Hydro"

At the beginning of this century there were increasing evidences that the central portion of Canada was destined to become an important centre for manufacturing industries. The Province of Ontario possesses many natural advantages and compares most favorably with any large areas of territory found elsewhere. Its important natural resources of agricultural areas, forests and minerals supply raw material for extensive and growing industries. It was recognized, therefore, that there were possibilities for an increased export of farm and manufactured products, and that there was no reason why the Province of Ontario—especially with an adequate supply of power—should not take a prominent place in world commerce.

It had become widely recognized that the growing dependence of the Province of Ontario upon outside sources for its fuel supply constituted a menace which it was greatly desired to remove, especially in so far as the coal requirements for the development of power were concerned. A number of public-spirited citizens impressed with the urgent necessity for directing their effort to the problem of utilizing the large water-power resources of the Province—more particularly Niagara Falls—as a means of accomplishing the extensive replacement of coal for the generation of power in Ontario, applied themselves to the solution of this problem.

It was in 1900 that a special committee of the Toronto Board of Trade made a report directing attention to the possibilities of securing an abundant supply of hydro-electrical energy from the Niagara river. There were, at this time, in many of the municipalities of Ontario, citizens who had recognized the desirability of

securing adequate supplies of electrical energy for both power and light at low cost. These citizens were studying the problem and were ready for co-operative action once a suitable scheme was formulated.

#### Public Interest Leads to Government Action

The interest manifested in the power problem increased and was greatly stimulated by means of public meetings, and by discussions in the Press. Appeals were made to the Provincial Government for legislation to enable municipalities to take action, and finally, as a result of the general movement on behalf of cheaper hydro-electrical energy, the Government of Ontario, in 1903, provided the means by which a Commission could be appointed by interested municipalities to investigate and report upon questions involving the supply and distribution of hydro-electrical energy.

The authority thus granted resulted in the appointment by the municipalities of Toronto, London, Brantford, Stratford, Woodstock, Ingersoll and Guelph, of the Ontario Power Commission, which, after a thorough investigation, published, in 1906, a comprehensive report dealing with the matters which had been referred to it. In this report, the availability and costs of power from the primary sources of coal, gas, oil and water were set forth, also data respecting the consumption and estimated future requirements of power in the districts concerned, the cost of the development of Niagara power, and other relevant matters.

When the results of this investigation became known to those interested, and even before the report was available for public distribution, the Provincial Government, in 1906, provided by special Act for the creation of the Hydro-Electric Power Commission of Ontario—the organization now in existence. In 1907, further legislation was passed strengthening and extending the powers of the Commission. One essential difference between the Act of 1903 and the later Acts of 1906 and 1907 is that under the 1903 Act various municipalities could combine into separate groups operating through separate commissions whereas in the later Acts provision is made whereby all municipalities appeal to the Hydro-Electric Power Commission of Ontario and make known their wants. The Commission is thus able to harmonize their various requirements and co-ordinate the municipalities into suitable groups or districts. In 1908 by-laws were passed by thirteen municipalities authorizing their officials to make contracts with the Commission for a supply of electrical power from Niagara Falls.

#### The Commission Contracts for its First Supply of Power

After much study of various schemes for securing the necessary power for distribution to the municipalities, it was concluded best to initiate this municipal enterprise by purchasing power by public tender from existing companies which had extensive plants already erected at Niagara Falls. Consequently, in 1908, the Commission, on behalf of the municipalities, entered into a contract with the Ontario Power Company for the supply of 100,000 horsepower of electrical energy at \$9.40 per horsepower-year until a load of 25,000 horsepower would be reached, after which the price would be \$9.00 per horsepower-year. The Commission proceeded

to build transformer stations and transmission lines for the distribution of this power to the contracting municipalities, and by the end of 1910 approximately 1,000 horsepower was being distributed to a number of municipalities.

#### New Sources of Power Supply Were Soon Required

This small load increased until in 1914 it was 77,000 horsepower, and by 1915 the Commission reached the limit of its contract with the Ontario Power Company for 100,000 horsepower. The Commission arranged for additional power supply from the Canadian Niagara Power Company of 50,000 horsepower, and from the Toronto Power Company of over 25,000 horsepower. Subsequently, in August, 1917, it purchased outright the Ontario Power Company with its plant capacity of 160,000 horsepower, which was increased to 200,000 horsepower in 1919 and, in December, 1920, acquired the Toronto Power Company, with its over 125,000 horsepower capacity. In 1920 the load was 356,000 horsepower. The new Queenston-Chippawa development provides for an ultimate development of over 600,000 horsepower. To-day, including exported power, the Hydro-Electric Power Commission is distributing about 650,000 horsepower. At the present time the Commission operates 22 water powers which, when fully developed, will have a potentiality of over 1,000,000 horsepower.

#### Various Hydro Systems were Formed as Circumstances Dictated

In passing, it may be well to explain that it was, of course, not possible to supply from a single source, such as from Niagara Falls, all the municipalities requiring power. From time to time, when various municipalities in a district adjacent to sources of hydro-electric energy, requested the Hydro-Electric Power Commission to take action on their behalf, separate hydro-electric systems were formed in localities in general proximity to the various sources of power supply.

For example, there are about twenty municipalities comprising what is known as the Severn system near Georgian bay. There are also the Eugenia, the Wasdells, the Muskoka, the St. Lawrence, the Ottawa, the Rideau, the Thunder Bay, the Central Ontario and Trent and the Nipissing systems in addition to the Niagara system. Of these the Central Ontario and the Nipissing systems were purchased in 1916 by the Government of Ontario, and their operation was entrusted to the Commission.

#### Transmission Network

The transmission lines of the Hydro-Electric Power Commission total over 3,000 miles in length, including about 500 miles of 110,000-volt lines. The greatest length of continuous 110,000-volt line is that between Niagara Falls and Windsor, a distance of approximately 250 miles. The transmission lines of the Eugenia, Wasdells and Severn systems are already interconnected, making interchange of power possible and increasing the reliability and economy of the combined systems, and the time is probably not far distant when the transmission lines of the whole of Southern Ontario will be connected up into one vast transmission system. In addition to the Commission's overhead lines, there are the distributing lines

of the various municipalities, totalling hundreds of miles in length. Lines have also been extended into the rural districts and many villages, hamlets, and individual farmers are receiving the benefits of "Hydro" power.

#### Financial Structure of "Hydro"

Certain principles, which the inaugurators of the "Hydro" undertaking believed sound, were laid as a basis upon which to administer the various assets in which the municipalities are concerned. These underlying principles briefly expressed are as follows:

*First:* The generation and transmission of power on a wholesale scale is dealt with by a Commission which, although appointed by the Government of the Province, acts independently in the capacity of trustee and agent for the partnership of municipalities.

*Second:* The local distribution of electrical energy within the borders of a municipality is, in general, under the administration of a public utilities commission appointed under the provision of the Public Utilities Act.

*Third:* Capital required for the plant for the generation and transmission of power is provided by the Government upon receipt of formal requisition from the Commission. Contracts are entered into between the Commission and the municipalities under the terms of which the municipalities undertake to repay in thirty years the moneys thus loaned by the Government.

*Fourth:* The local distribution system is financed by the issue of municipal debentures. Provision is made in the rates charged to the ultimate consumers for revenue with which to retire these bonds also, usually in twenty years.

*Fifth:* The "trustee" Commission supplies power at wholesale rates to the municipalities, charging each municipality the actual cost. To do this, an interim charge is made monthly, based upon the estimated cost, and, at the end of each year, credit or debit adjustment is made of the amount charged in order to make up the actual total cost—no more and no less. The "cost of power" includes all the usual costs of operation and maintenance of the generating, transforming and transmission plant and equipment, and, in addition, the annual interest charges on the moneys borrowed for the initial cost of installation, also provision for renewal (depreciation) and sinking fund reserves, as well as a special reserve fund for contingencies.

*Sixth:* Each municipality sells electrical energy to its own local consumers at rates and under conditions approved by the Commission. The rates charged to its own consumers by a municipality are made sufficient to take care both of the cost of distribution, within the municipality, and of the estimated cost of power to be paid to the Commission by the municipality. The cost of distribution is ascertained in a manner identical with that used by the Commission in arriving at its wholesale costs.

*Seventh:* Under the Power Commission Act, the Commission is required to determine, annually, the actual cost of service supplied to the municipal corporations by the local commission for such strictly municipal purposes as street lighting, street railways and operating electric-motor-driven pumps

in waterworks, and if any profit has accrued through the charging of the rate used throughout the year, this surplus is handed back to the municipality.

If a municipality desires to obtain a supply of power from the Commission, a vote is taken at the polls, and if the result be favorable an enabling by-law is passed whereby the municipality is empowered to make a contract with the Commission for the amount of power required. The Commission's engineers are at the service of the municipality to enable a reasonable estimate of the requirements to be made. The contract having been duly executed, a money by-law must then be passed authorizing the Municipal Council to issue the debentures necessary to cover the cost of constructing a local distributing system within the limits of the municipality; the Commission then proceeds with the work of building the necessary transmission lines, sub-stations, etc. The municipalities repay the cost of the project out of earnings, spread over a period of thirty years, all such items as maintenance, depreciation, and sinking fund being fully taken care of. At the end of thirty years' time the entire plant and equipment will belong to the municipalities and thus the people will eventually be the owners of a fully paid-up unde taking.

"The basic principle of the whole "Hydro" project is a partnership of municipalities formed to obtain power at cost, each municipality paying its proportion of the cost or the service received. The Commission, acting as agent and trustee for the municipalities, exercises both administrative and constructive functions, and by application of the principles just mentioned, has evolved a well-defined and successful working policy for the development, transmission and distribution of hydro-electric power under municipal ownership.

#### Commission's Extensive Annual Report

Some idea of the great success attained and of the various operations involved in the working out of the principles basic to this municipal undertaking may be obtained from the Annual Reports of the Commission. There has recently been issued the Fifteenth Annual Report. It is a volume of 700 pages and gives more information respecting the operations of the Commission and the associated municipal electric utilities than any annual report of any other system of electric utilities, regardless of where operated or whether publicly or privately owned.

The financial statements, the statistical data and the general information given in the Annual Report are so arranged and presented as to give the reader a ready grasp of the Commission's operations. Not only does the Report record the progress made during last year, but it gives, in addition, the cumulative results for the various periods during which operation has been maintained in the respective municipalities. A review of the various data will disclose many interesting features. Thus, by way of illustration, the automatic reduction in the debenture debt, due to the annual principal or sinking fund payments being provided for out of revenue, and the remarkable accumulation of assets, reflect the satisfactory condition of the Hydro utilities generally. For example, a tabular statement is presented which shows, in condensed form, the relation of assets to liabilities in fifty Hydro municipalities. In the first eighteen municipalities the quick assets such as cash, bonds, accounts receivable and inventories exceed in value the total liabilities, including the debenture balance, and they may be considered as being

out of debt. In the remaining thirty-two municipalities the excess of liabilities over the quick assets is relatively so small that a number of them will be transferred to the "out-of-debt" list when the books are closed at the end of 1923. Such results are irrefutable.

#### MUNICIPAL INVESTMENTS, RESERVES AND SURPLUS

System	No. of municipalities	Total assets	Sinking fund debentures, paid and surplus	Plant renewal reserves	Equity in H.E.P.C. sinking fund	Total reserves, surplus and equity
		\$ c.	\$ c.	\$ c.	\$ c.	\$ c.
Niagara.....	149	47,514,037 00	9,590,208 00	5,594,142 00	1,391,696 00	16,576,046 00
Severn.....	17	951,809 00	419,176 00	140,331 00	61,979 00	621,486 00
Eugenia.....	23	1,124,737 00	232,404 00	95,614 00	36,380 00	414,398 00
Wassella.....	8	122,350 00	14,890 00	9,560 00	8,038 00	32,488 00
Muskoka.....	2	134,470 00	49,562 00	16,678 00	4,518 00	70,759 00
St. Lawrence..	10	581,239 00	189,956 00	38,270 00	18,704 00	246,931 00
Rideau.....	5	500,883 00	67,865 00	41,958 00	.....	109,823 00
Ottawa.....	1	1,922,111 00	421,471 00	426,480 00	.....	847,951 00
Thunder Bay..	1	1,122,569 00	494,221 00	76,998 00	22,115 00	593,335 00
Trent.....	10	1,299,494 00	492,308 00	72,779 00	.....	565,087 00
Total....		226,55,274,702 00	12,022,066 00	6,512,813 00	1,543,434 00	20,078,314 00

#### Low Rates for "Hydro" Service

Throughout "Hydro" municipalities, the use of electrical appliances is greatly promoted by the low cost of electricity. In most of these municipalities, the average family may take full advantage of the cleanliness, convenience and safety of electric lighting for less than \$1.00 per month; while for a small additional cost, electric fans, irons, washing machines, vacuum cleaners, toasters and certain classes of light cooking appliances may be utilized. Cooking by electricity is rapidly becoming popular.

As is customary in electrical supply, the rates in Hydro municipalities are so graded that the rates for all energy used over a certain consumption are lower than for the initial consumption. In many Hydro municipalities this secondary or "follow-up" rate is as low as 0.9 cents net per kilowatt-hour, and last year the Commission felt justified in inaugurating a scheme whereby the maximum "follow-up" rate in all Hydro municipalities is 1.8 cents net per kilowatt-hour, for domestic service.

I have here a table presenting returns published in the last Annual Report of the municipalities which conveys an idea of what the charges are for light and power in some of the larger municipalities of Ontario. I shall not read the details of the table, because I understand that it will be presented in the printed copy of our Proceedings. I shall, however, mention some representative instances.

In Toronto, for example, 90 miles distant from Niagara Falls, the average net charge to consumers inclusive of all charges is, for residence service, 2.1 cents per kilowatt-hour, for commercial service, 2.7 cents per kilowatt-hour, and for power service \$22.58 per horsepower per year.



In Hamilton, 50 miles from Niagara Falls, the corresponding rates are, for residence service, 1.9 cents per kilowatt-hour, for commercial service 1.3 cents, and for power \$14.49 per horsepower per year.

At Windsor, 250 miles from the point of generation, residence service is 2.6 cents per kilowatt-hour, commercial service is 2.7 cents per kilowatt-hour, and power is \$28.64 per horsepower per year.

I will conclude with the town of Galt, with a population of about 13,000, situated 93 miles from the Falls. In Galt, the average net charge to domestic consumers is 1.8 cents per kilowatt-hour, for commercial service 2.0 cents per kilowatt-hour and for power \$17.55 per horsepower per year.

CHARGES FOR ELECTRICAL SERVICE IN HYDRO MUNICIPALITIES

Municipality	Population 1921	Approximate transmission distance in miles	Average net charge to consumers inclusive of all charges		
			Residence service cents per kilowatt-hour	Commercial service cents per kilowatt-hour	Power service dollars per horsepower per year
Toronto.....	522,942	90	2.1	2.7	22.58
Hamilton.....	118,243	50	1.9	1.3	14.49
Ottawa.....	112,899	1	1.4	1.9	11.75
London.....	59,784	132	1.8	1.7	22.66
Windsor.....	38,530	220	2.6	2.7	28.64
Brantford.....	31,362	85	1.9	2.6	16.33
Kitchener.....	22,717	102	1.7	1.9	18.78
Peterborough.....	21,439	2	2.8	1.5	16.46
St. Catharines.....	20,961	9	1.3	1.4	16.40
Georgetown.....	18,027	77	2.4	2.3	17.16
Niagara Falls.....	15,895	1	1.5	1.2	14.32
Galt.....	13,332	93	1.8	2.0	17.55

#### Rural Distribution

I should like here to make a brief reference to some of the results achieved by the Hydro in bringing to small communities and to individual farmers the inestimable advantages of electrical service. In no way is the difference between private and public ownership of electric utilities more strikingly shown than in a comparison of the services rendered to the smaller communities and rural districts.

The difficulties of electrification of country districts are universally recognized. Generally speaking, from the viewpoint of the central station this class of consumer is unprofitable. Only a small return can be secured on any capital invested. The operating costs, due to the distances to be covered, are excessive. The load per mile of distribution is small—compare, for example, the number of services connected in a mile of city streets and to a mile of rural line. The load factor is low and the demand irregular, being controlled in part by weather conditions which affect most farmers in a given locality in a similar manner. Farmers

often use machinery larger than is really necessary for the work they have to do. When the work is performed electrically it may often be done more profitably by smaller machines taking less power to operate.

In spite of the handicaps inherent in rural distribution of electrical energy, the Hydro-Electric Power Commission has made substantial progress in this department of its activities. Its first rural lines were built late in 1912, but in 1917, the construction of rural lines was suspended, due to the high costs resulting from War conditions. The legislation enacted in 1911 to meet the conditions of that period which consisted, so far as rural service was concerned, of requests from groups near urban centres, was later found to be inadequate, and, in 1920, was amended to provide for conditions then obtaining. Under this amended legislation, zones or districts are determined in which electrical service is given to each of certain specified classes at the same rates throughout the whole district based on average conditions in the district. The boundaries of such districts are not arbitrary geographical limits, but depend upon the economical distances which may be served from a distribution centre of city, town or village.

The total mileage of rural lines at present operated by the Commission is 835 miles, giving electrical service to about 13,500 customers.

Although the aggregate load distributed to the rural dwellers is, and must always be, but a relatively small proportion of the energy distributed by the Hydro, its influence upon the economic life of the Province of Ontario will doubtless be far-reaching and is already a factor of importance. Agriculture still ranks as the most important of our industries and in these days with farm labor scarce and expensive, anything that takes its place is a great help to the farmer, for, as is universally acknowledged, upon him in the last analysis rests the prosperity and welfare of the community.

#### Character of Service Received in Rural Districts

Hitherto the rural resident has thought chiefly of electrical service in connection with lighting, but his greater need is for convenient power. The appliances that are so helpful to the city dweller, such as washing machines, irons, fans, etc., are of even greater help to the farmer's wife; but, in addition, the farmer can make use of a large number of devices which are even more labor-saving than those used in the city, such, for example, as water-pumps, cream-separators, churns, milking machines and all machinery usually worked by man or other power. These can all be operated by quite small motors. Where larger capacity electrical service can economically be installed, additional machinery, for which the farmer usually employs auxiliary power, can be operated electrically. Such machinery, for example, as buzz and drag-saws, choppers, root-pulpers, ensilage cutting boxes and threshers, also can be operated electrically.

#### Rural Rates Are Favorable

Respecting the costs of electrical service to rural customers, the rates are based upon service "at cost," and, as in urban centres, are made up of two parts, a service charge and a consumption charge, the latter being in the form of a first and second kilowatt-hour charge based upon the cost of power at the point of

delivery. As typical of the charges that obtain, it may be stated that for the class known as "light farm service," which includes the lighting of farm buildings, power for miscellaneous small equipment, power for single-phase motors not to exceed 3-horsepower demand, or for an electric range, the range and motors not being used simultaneously, the monthly charge would be from \$6.00 to \$8.00. For "heavy farm service," which includes, in addition to the above, power for motors up to 5-horsepower demand and electric range, or 10-horsepower demand without electric range, the monthly charge would be from \$17.00 to \$19.00.

If the distribution of electrical energy in Ontario had been in the hands of private corporations, most of the thousands of customers in rural Ontario, including the smaller towns and villages, to whom the Hydro now distributes electricity, would still be without the benefits of electrical service. Except where heavy loads are obtainable—as for example in the irrigation districts of California—the rural consumer is usually unprofitable and companies will not consider extending their lines to such customers.

The policy of the Commission has been, and is, to give the widest distribution of power consistent with possible limiting costs. The energies of its engineers have been directed to ascertaining the most economical methods of rural distribution. Much pioneer work has already been undertaken and the results achieved have more than justified the efforts.

#### The Queenston-Chippawa Development

The Hydro-Electric Power Commission has itself initiated some important power developments, and as you know has under completion the largest single hydro-electrical power development in the world,—the Queenston-Chippawa plant on the Niagara river. During your stay, I understand, it has been arranged that you shall take the time necessary to give this work your personal inspection. It is appropriate, therefore, on this occasion, to refer very briefly to this plant, calling attention to some of its more prominent features.

The general scheme of development comprises an intake structure in the Niagara river at Chippawa; the deepening and widening of the Welland river between Chippawa and Montrose, a distance of  $4\frac{1}{2}$  miles; the construction of a canal  $8\frac{1}{2}$  miles long from Montrose to the forebay and screen house at a point on the cliff about a mile south of the village of Queenston; and the construction and equipment of a power house, in the gorge, immediately below the forebay.

Previous power developments on the Niagara river only utilized that portion of the total fall of the river which occurs in the vicinity of the falls, and, for the most part, even this amount of head has been inefficiently utilized; but the basic conception of the Queenston-Chippawa development is the utilization of the greatest possible amount of the total fall of the Niagara river between lake Erie and lake Ontario at the highest possible efficiency. Of this total fall of 327 feet, about 10 feet occurs in the upper Niagara river from lake Erie to Chippawa and in the lower river from Queenston to lake Ontario. These 10 feet it is impossible to reclaim for power purposes. Of the remaining head, about 12 feet is required to convey the water through the canal.

From the foregoing, it will be seen that the average head actually available at the power house is 305 feet, which means that 30 horsepower is developed for every cubic foot of water that flows through the canal per second. That this is a great forward step in economy is apparent from the fact that only 16 horsepower is obtained from each cubic foot of water flowing per second in the most efficient of the present three plants on the Canadian side of the river at Niagara Falls; thus every cubic foot of water used in the Queenston power house will earn nearly twice as much revenue as if it were used at Niagara Falls.

Seventeen million cubic yards of rock and earth have been excavated, and the canal is lined throughout with concrete; not less than 450,000 cubic yards of concrete have been used altogether on the whole project. Bridges had to be built to accommodate a number of important railway lines and highways intersected by the canal.

Eighty-two miles of standard gauge construction railway track were laid to handle excavated material, and the majority of the locomotives used were electrically driven. Many large shovels, five of them being the largest in the world and electrically operated, were used on this work; each of these five shovels could load a car of 20 cubic yards capacity, standing 60 feet above the shovel, in one and a half minutes.

The water of the Niagara river, after leaving the canal proper, enters a forebay which is practically a triangle-shaped enlargement of the canal, whence it enters the penstocks, or tubes, which lead it down the face of the cliff to the turbines in the power house which is located right on the edge of the river at the bottom of the gorge.

The turbines are technically described as of the vertical single-runner type; their capacity is 60,000 horsepower each, being greater than that of any others previously built.

Each electric generator is mounted directly above its own turbine, the revolving parts of each having a common shaft. The heaviest single integral part of one of these huge units weighs 600,000 lbs. Air is employed for cooling these generators and the warm air issuing therefrom is used in winter to warm the building; the weight of air required every  $2\frac{1}{2}$  hours for cooling each generator is 1,380,000 lbs., which equals the total weight of the generator itself.

Three-phase alternating electric current is generated at 12,000 volts, the frequency being 25 cycles per second; the current from each generator passes through its own switches and transformers, the latter being used to step up the voltage from 12,000 volts to 110,000 volts, and the current is transmitted at 110,000 volts on the Commission's high-tension lines all over south-western Ontario.

Five of the large new generators are now under load supplying the Niagara system, while of the remaining generators, three are under order for earliest possible delivery and one of these will be in operation within a few months. The power canal provides for ten generators with an ultimate plant capacity of over 600,000 horsepower.

### There Has Been Much Unjust Opposition

You must not conclude that the progress indicated by the statements I have been making was always "plain sailing." There has been a great deal of unfair opposition to the Commission and the municipalities in connection with their hydro-electric undertaking, and criticism of the results obtained; however, this criticism has not come from the municipalities interested, but from outside sources. Probably no public reform has experienced more unfair misrepresentation than has the work of the Commission.

The many unjust attacks directed against the Commission have usually followed along a well-beaten track. They have consisted of the making of grossly incorrect and misleading statements; the garbling of documentary and other data relating to the Commission's work and the employing of such garbled material as premises from which to derive conclusions. Pronouncements have been made based upon absolutely inadequate comparisons; important factors, even to the disregarding of most pertinent engineering data have been ignored; comparisons have been made between unlike quantities and involving unlike conditions so that the comparisons drawn have been useless; consideration of engineering economics has been ignored; essential data have been withheld; and erroneous statements have been made in a most dogmatic manner in the hope of imposing upon the credulity of those not having knowledge of the facts. By unjust processes, such as those just mentioned, the work of the Commission has been grossly misrepresented, but in spite of it, the work of the Commission has prospered beyond all expectation, and no matter where from or how the attacks originate, none ever come from the over three hundred and fifty municipalities whose citizens know that their enterprise is a great success,—a success of which they are specially reminded every month as they pay their relatively small monthly bills for electrical power and light "at cost."

### The Future of "Hydro" Full of Promise

In concluding, I should like to say a word with respect to the probable future demands upon the Hydro-Electric Power Commission of Ontario.

I have already referred to the phenomenal growth in the demand for Hydro power. Commencing in 1910 with an initial load of less than 1,000 horsepower, this increased until in 1915, that is within five years, the Commission reached the limit of its first contract with the Ontario Power Company for 100,000 horsepower, while to-day, including exported power, the Hydro-Electric Power Commission is distributing about 650,000 horsepower.

Since the inauguration of the Hydro there has been purchased on behalf of the co-operating municipalities no less than twenty-two water powers, thirty hydraulic generating plants, and over sixty electrical distribution systems. At the present time, the Commission operates electrical power undertakings which, when fully developed, will have an aggregate capacity of 1,000,000 horsepower.

Notwithstanding these provisions, the Hydro-electric systems administered by the Commission—including the Niagara system—are practically all faced with an oncoming power shortage. It is true that this is not the case, as yet, with the Nipigon development at the head of the Great Lakes, but even here it will not be long before the available power will be requisitioned.

It should be appreciated that this phenomenal growth in demand for electrical energy for power and light has continued even during a period when industry has not been expanding as it was prior to the Great War. The demand for hydro-electric energy, in the Niagara district especially, has been increasing at a phenomenal rate. This has been brought about chiefly by increased demands for general domestic and commercial purposes. In the last two or three years a new impetus was given to the building trades, entailing a substantial addition to the lighting load, both for premises and street purposes.

The domestic consumer has been discovering that electrical appliances, such as electric stoves, washing machines, irons and other devices, can be operated at relatively low cost, thereby greatly reducing the burden of general housekeeping. Such appliances are being widely adopted.

In my home city—the city of London—ten years ago the average monthly consumption of electricity per household was less than 20 kilowatt-hours, to-day it is 75 kilowatt-hours, thus showing an increased growth of consumption of nearly 300 per cent. The point of saturation has not yet been reached. There are thousands of homes planning to install additional domestic electric appliances which will greatly increase the total demand for electrical energy.

In a word, if, during the period when general industrial activity has scarcely reached normal, there has been a demand for electrical energy for general purposes such as to absorb the available supply, where is the electrical energy to come from in order to meet the large demands of expanding industry which so many far-sighted citizens, both in the United States and the Dominion of Canada, believe must come in the very near future in order to supply the world demand for manufactured commodities?

### Chief Sources for More Electrical Energy

The answer to this question of where the power is to come from is, that there will be no place for this power to come from unless provision is made immediately to develop large new sources of power supply.

What, then, are the chief sources for additional power supply? For southerly Ontario, extending, say, from Windsor on the west, to the Quebec boundary on the east, the two chief sources of power supply are the Niagara and the St. Lawrence rivers.

So far as the easterly portion of the Province of Ontario is concerned, there is an abundant potential supply of hydro-electric energy on the St. Lawrence river in the vicinity of Morrisburg and at the Long Sault rapids. This is the international boundary portion of the St. Lawrence river. Various engineering projects for the development of the St. Lawrence have been suggested; some by our own engineers, some by engineers in the United States, and some by the International Joint Commission. It is not my intention to discuss details. It is the opinion of all concerned that, irrespective of what particular project is decided upon, the St. Lawrence river may be developed in the combined interests of navigation and of the water power of both countries,—the Dominion of Canada and the United States.

The Province of Ontario owns a fifty per cent interest in the power in the international portion of the St. Lawrence, to which I have referred, and this half share amounts to over 800,000 horsepower. The other half, of over 800,000 horsepower, is owned in the United States.

It has been observed through the daily press and in other ways that many and varied interests, from the agricultural domains of both the United States and the Canadian North-West, from communities bordering the Great Lakes, from organizations in the Province of Ontario, from the State of New York and elsewhere, have been advocating united action to bring about the development of the St. Lawrence river.

#### Co-operation Required for Action Respecting the Development of the St. Lawrence

The people of the Province of Ontario are ready to co-operate with other interests in this great undertaking, provided, of course, that Ontario's rights to the full benefit from the development of her share in international waters including of course, her water powers, are not jeopardized.

You know it takes several years to initiate and construct the works and commence the transmission of electrical energy from these large hydro-electric plants. Where would the Province of Ontario be to-day if, prior to the year 1910, Ontario municipalities and the Hydro-Electric Power Commission had not foreseen the possibility of greatly expanding power markets and had not provided for the present heavy demand by initiating and constructing the new Queenston-Chippawa plant?

The circumstances when the Queenston-Chippawa plant was contemplated were not of the same magnitude, nor did they appear to be so pressing as they are to-day. Present conditions indicate a power shortage which, probably, cannot be entirely avoided. In fact, drastic measures may, ere long, have to be taken to curtail certain electrical usage in order that such hydro-electrical energy as is available may be applied to the best and most efficient uses.

The Hydro-Electric Power Commission has been engaged upon studies of how best to solve this problem of a prospective power shortage. You, gentlemen, who are interested in the furthering of publicly-owned utilities know that you cannot move very much in advance of public opinion. On all hands, however, with the strong demand for electrical energy on the part of the public, there is, now, a well-formed public opinion and hence there is practically no reason why projects for the supply of low-cost electrical energy could not, at this period, be carried forward to successful completion much more readily than could have been done ten, fifteen or twenty years ago.

#### An Electrical Power Shortage in Prospect

A review of the circumstances which govern in the electrical light and power situation clearly shows, I believe, that there is not now in sight from the sources of power already developed, sufficient hydro-electrical energy to meet the demands of the early future. The circumstances which I have outlined as applicable to the Province of Ontario, differ but little, so far as I can learn, from general conditions prevailing in many of the States to the south of us.

The interests of many of the States of the Union are common to those in this Province. With this unity of general interests, there should be found, and as soon as possible, some plan upon which all interested parties can agree, making for the development of the St. Lawrence and the Niagara rivers in the general interests of navigation and of power. If effort is to be made along such lines it should be made by those who are intelligently informed respecting the various interests and issues involved. There is a good deal for some persons to learn upon this subject. The development of the St. Lawrence river is by no means a new project,—a great deal of literature exists discussing many phases of this great problem. Personally, I believe that agreement on the part of the federal and other governments involved upon some unified general plan for the development of the St. Lawrence river could be arrived at in such a manner as would permit this work to be initiated and, as circumstances warrant, carried forward to completion. The development of the St. Lawrence would constitute a source of hydro-electrical energy which could be employed as a sound basis upon which publicly-owned, controlled and operated hydro-electric utilities in the United States and in Canada could satisfactorily be established.

#### St. Lawrence Power is Low-cost Power

The quantity of St. Lawrence power which can be produced is large. It is ample to serve as a sound basis upon which many of you could materialize your doctrines of public-ownership. Had the Commission had its way, St. Lawrence power would now be under development and would be aiding to build up industries in Ontario.

At the end of fifteen years of its work, the Commission and the Hydro municipalities find themselves administering assets aggregating \$250,000,000. Yearly the Hydro municipalities are expending additional millions to increase and improve their municipally-owned undertaking. The basis of the whole project is power and light for the people *at cost*.

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